Scale and shift invariant time/frequency representation using auditory statistics: application to rhythm description

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Scale and Shift Invariant Time/Frequency Representation Using Auditory Statistics: Application to Rhythm Description.

Outline

Objectives:
- creating a representation of the audio signal that differentiate musical rhythms

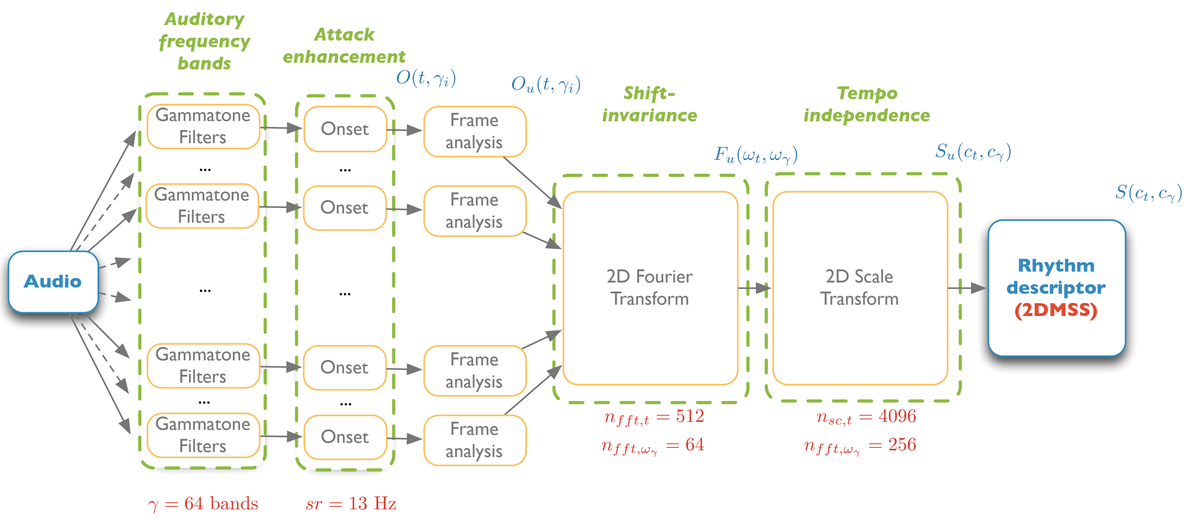
Constraints:
- creating a representation which is invariant to tempo and to temporal-shifts

Propositions:
- Two new 2D (time/frequency) representations of the audio content: 2DMSS and MASSS
- New Dataset

Applications:
- use this representation to do auto-tagging, search by similarity

Rhythm description

Method 2DMSS



2DMSS= 2D Fourier Transform, followed by a 2D Scale Transform known as Fourier-Mellin Transform in Image processing

2D Scale Transform:

$$S(c_t, c_\omega) = \int_{-\infty}^{\infty}\int_{-\infty}^{\infty}\left(X(e^t, e^\omega)e^{\omega/2}e^{t/2}\right)e^{-jc_\omega\omega - jc_t t}d\omega dt$$

Pros/Cons

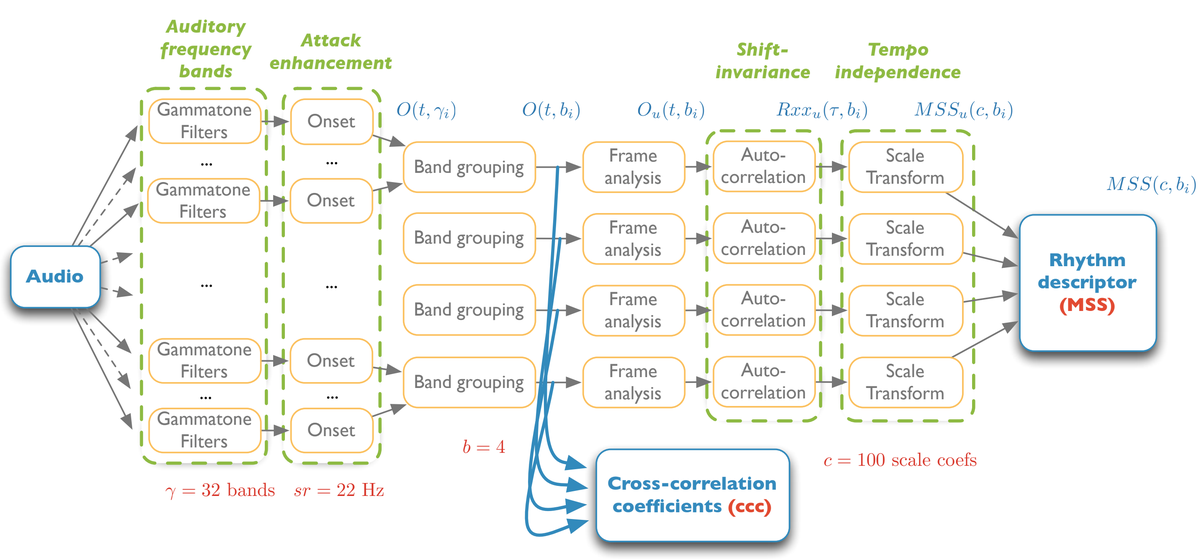
Pros: models the relationship between frequency bands and time bins with shift-invariance and scale-invariance

Cons: produces also shift-invariance over frequencies which is an undesired property

Can differenciate:

But not:

Method MASSS

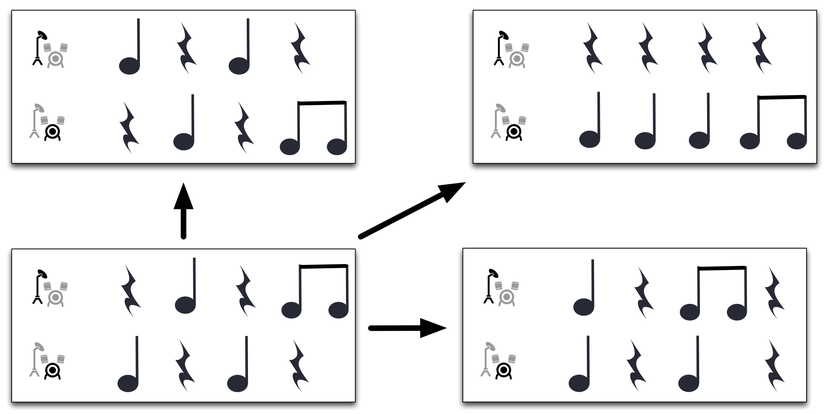


MASSS = Modulation Scale Spectrum (MSS) + Auditory Statistics (ccc) [McDermott, 2013]

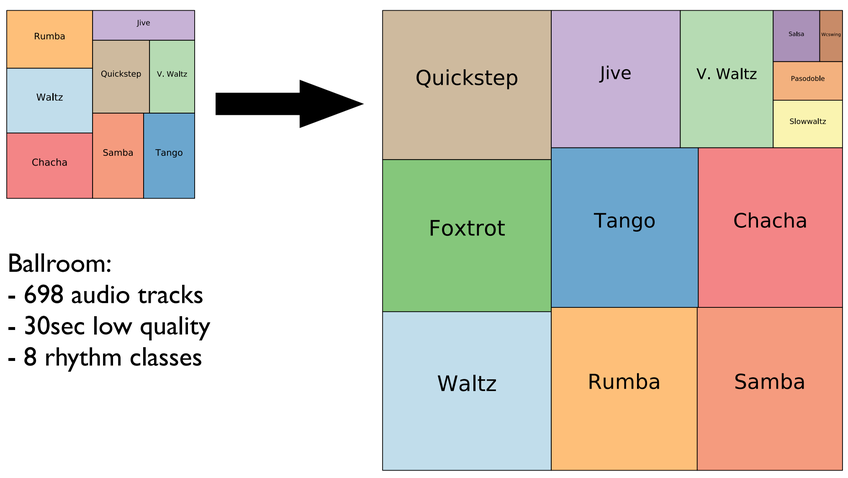
Auditory Statistics (ccc) = Cross-correlations between different auditory frequency bands

Late-fusion of MSS and ccc

Can differenciate:



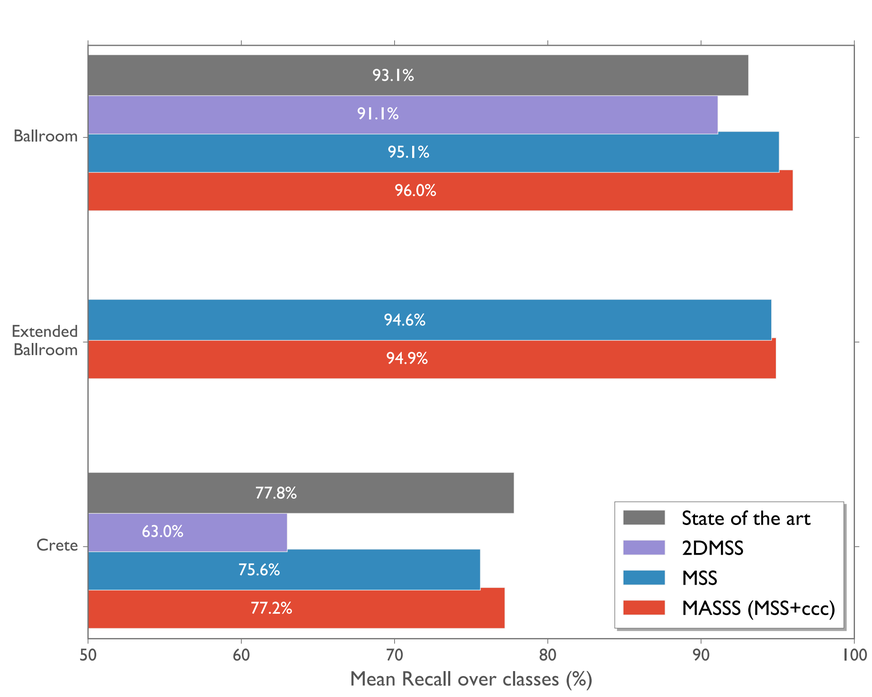
New dataset : Extended Ballroom



Ballroom:
- 698 audio tracks
- 30sec low quality
- 8 rhythm classes

Extended Ballroom:
- 4.180 audio tracks
- 30sec high-quality
- 9+4 rhythm classes
- similarity annotations

Results



Classification
- SVM (MSS, 2DMSS, ccc models)
- Logistic Regression (late-fusion)

Analysis of results:
- 2DMSS is not sufficient
- MASSS
-- improves state-of-the-art method by 3% on Ballroom
-- equals state-of-the-art on Cretan dances dataset.

Conclusion:
- modeling frequency bands inter-relationship through auditory statistics improves rhythm description

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